

Brazil joins the rocket business

There was a time when the technological progress of a developing country could be gauged from the size and scope of its national airline. A more recent yardstick is the ability to build aircraft—either under licence or to an indigenous design. Today, independence in rocket and satellite technology is a better indicator.

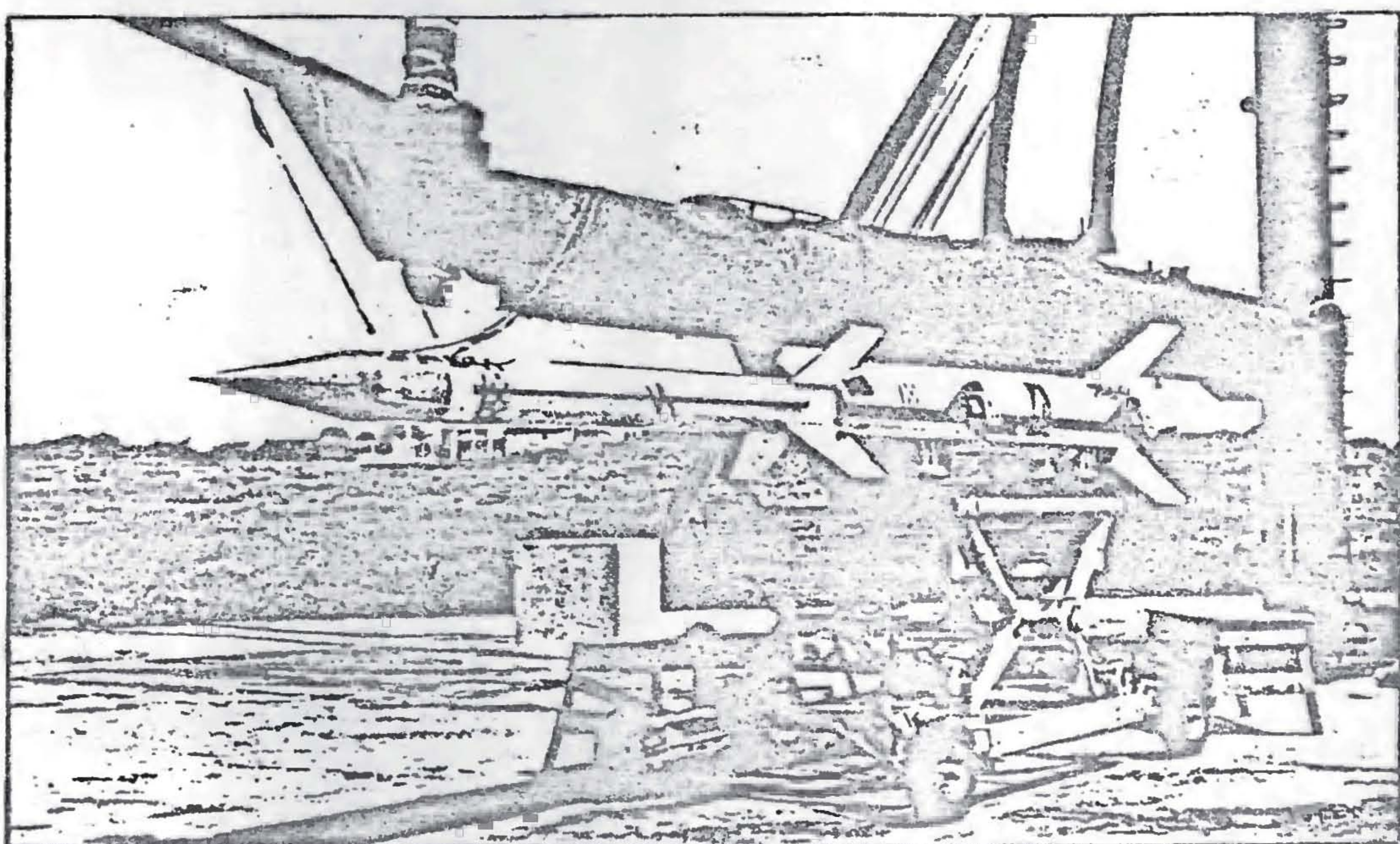
India is the leader on this scale, having achieved launcher independence in July 1980, when its SLV-3 first put a satellite into orbit. Brazil has similar aspirations, and is already using a healthy sounding-rocket programme to provide the technological building blocks. Its goal is a rocket able to place 150kg in low-Earth orbit. Called Veiculo Lançador de Satélites (VLS), Brazil's rocket would be several times more powerful than India's SLV-3, and almost on a par with America's Scout.

Development of VLS has been entrusted to the Centro Técnico Aeroespacial (CTA), Brazil's principal organisation for aerospace research. CTA director Major-Brigadier Menezes emphasises that VLS is more than a technological exercise—Brazil hopes to sell launches to other developing countries.

The VLS payload is small when compared with Western satellites, typically weighing a few thousand kilograms at lift-off. So there is no danger of VLS competing with Ariane or Space Shuttle. What VLS does offer is a relatively cheap way of orbiting a small satellite. This could make sense for straightforward missions with specific goals such as data-collection or Earth observation.

Satellites of this kind are being developed by another research organi-

By the end of this decade Brazil will have a rocket able to put small satellites into orbit. David Velupillai reports from Natal.



A Sonda III is prepared for launch from Barreira do Inferno. The sounding rocket is raised into a near-vertical position before being launched along a guide rail

sation, INPE, for flight aboard VLS in the late 1980s-early 1990s. The first satellite is intended to acquire and relay data from remote parts of Brazil—weather information, for example. Because this is a new field for Brazil, much of the satellite's payload will be technological, aimed at proving the design of components. First flight would be in the second half of 1989, when VLS is due to make its debut. The satellite would be compatible with equa-

torial or polar orbit. Subject to weight constraints, polar orbit is more likely.

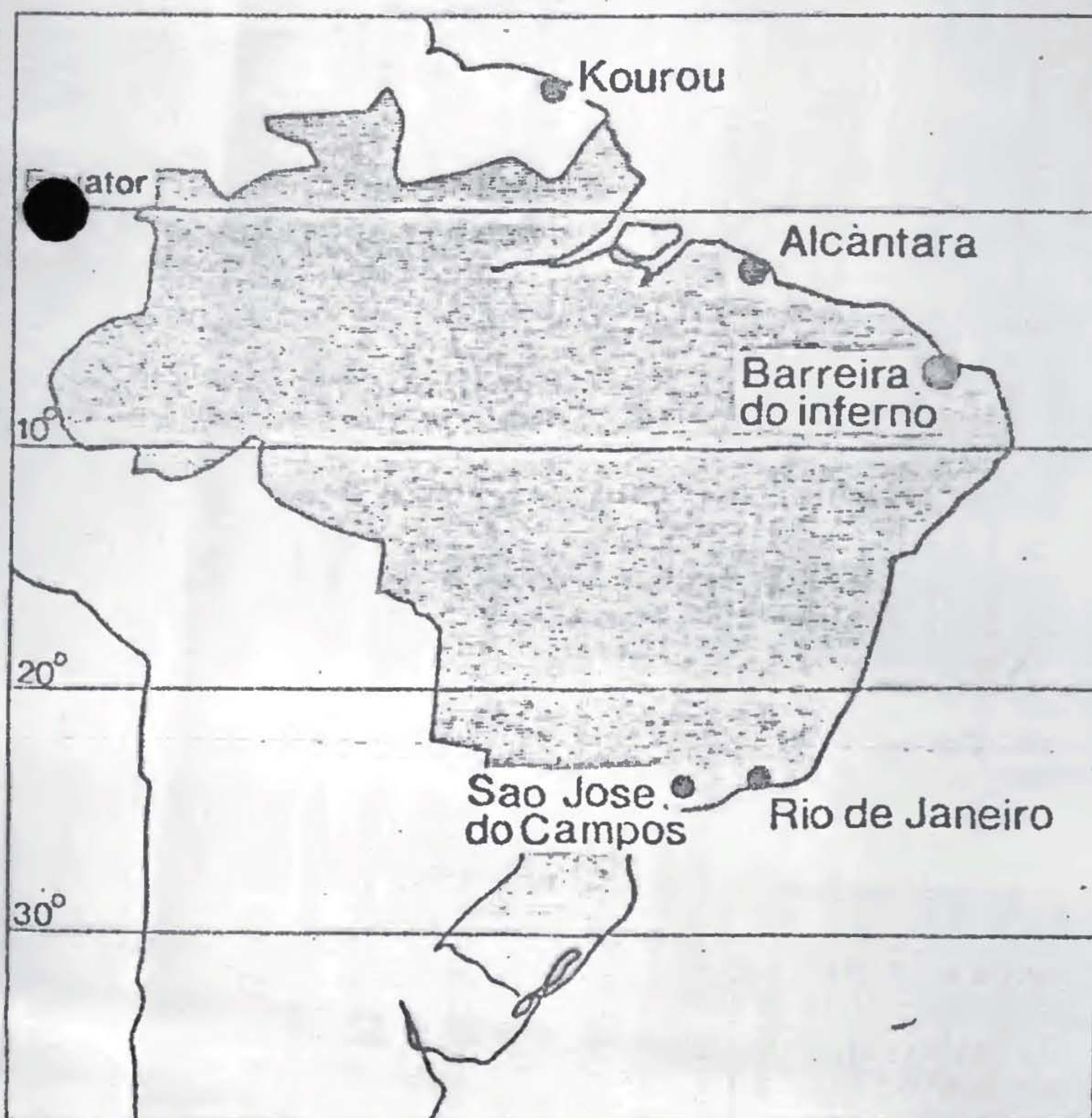
Design life is two-and-a-half years, the time it would take for the low-Earth orbit to decay. Launch weight would be 150-200kg, depending on orbit height, inclination, and improvements in VLS performance.

INPE's next type of satellite will feature more sophisticated data-collection and less technological payload. It would be introduced around 1990, and would have a similar life and weight to its predecessors.

Next comes an Earth-observation craft, featuring a mixture of Western- and Brazilian-built sensors. The aim would be to monitor natural resources, such as crops, forests, and water. A resolution of around 50m is planned. First flight could be as early as 1991. Again, weight and design life would be similar to those of its predecessor. The orbit would be polar.

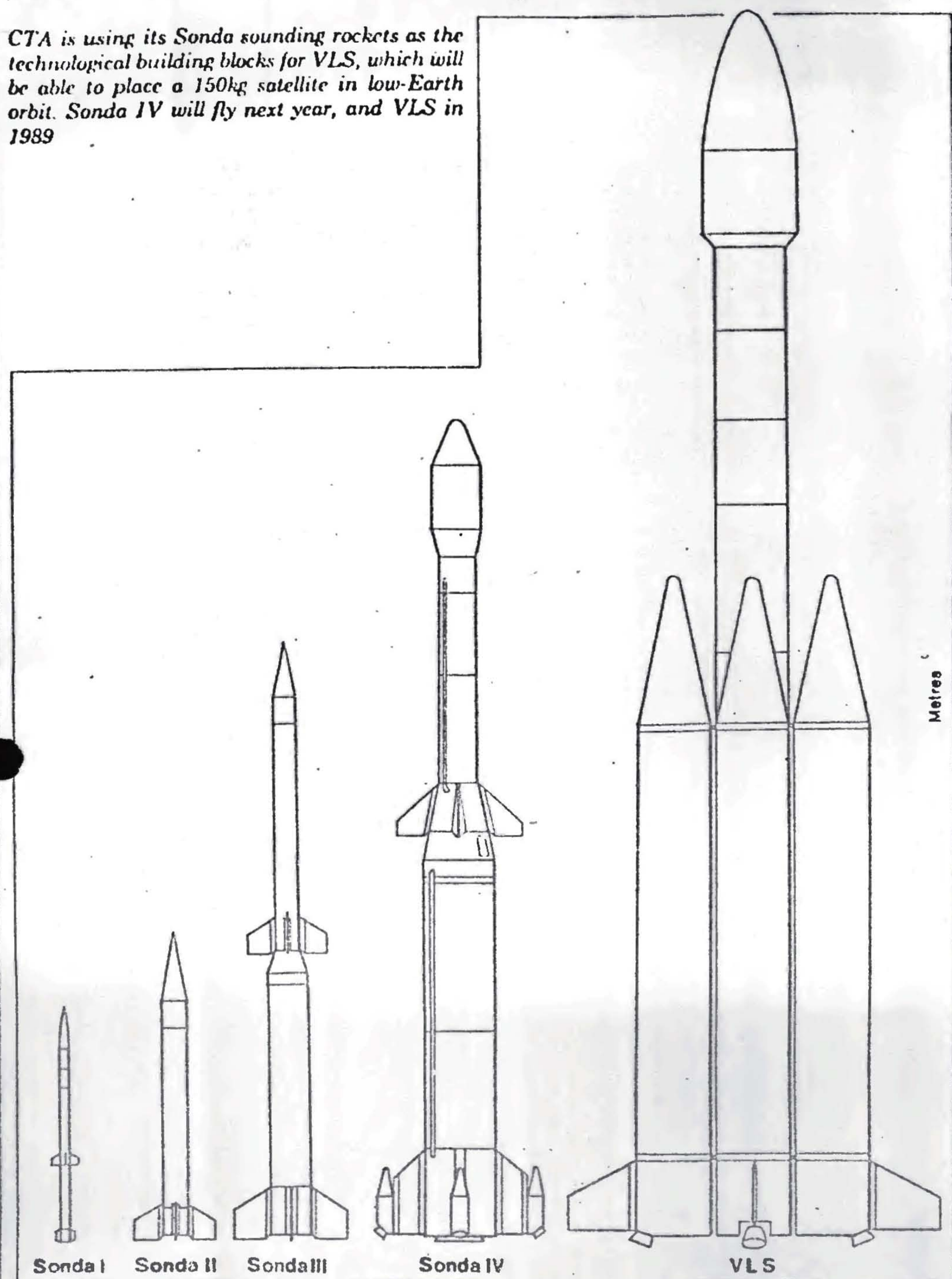
Further in the future are meteorological and maritime observation satellites, but today INPE is concentrating on the design of early satellites and their payloads. It has said yes, in principle, to flying a payload on a Space Shuttle Getaway special as one way of building up space experience. The Brazilian sounding rocket programme is another.

Brazil recognises that its space efforts have some way to go before they can provide the kind of domestic communications satellite network needed today. Embratel, the Brazilian telecommunications administration, is therefore buying two communications satellites from the West as an interim measure. Called Brasilsat or SBTS, the craft are



Brazil will begin construction of a new rocket range at Alcântara during 1985. Alcântara has less restriction on northward (polar) launches than the existing Barreira do Inferno range, and is even closer to the equator

CTA is using its Sonda sounding rockets as the technological building blocks for VLS, which will be able to place a 150kg satellite in low-Earth orbit. Sonda IV will fly next year, and VLS in 1989



BRAZILIAN ROCKETS

Rocket	Typical payload	Remarks
Sonda I	4.2kg to 65km	Out of production
Sonda II	44kg to 80km	50+ launches in past 15 years. Now 2-3 launches a year.
Sonda III (M-M1)	60kg to 600km (140kg to 275km)	First flight in February 1976, with 18+ launches to date. Now 5-10 flights a year.
Sonda IV	500kg to 750km	First flight in second half of 1984. Attitude control of rocket attempted for first time.
VLS	150kg into 250km x 550km orbit inclined at 98° OR 100kg to 700km-high circular orbit inclined up to 30°	First Brazilian rocket to orbit. Debut flight in 1989. Uses attitude control and clustered first-stage motors.

being built by Spar Aerospace. They will be launched in February and August 1985, aboard Europe's Ariane.

For CTA, creating VLS is a natural extension of its sounding rocket work. Sonda III is the current workhorse, with almost 20 launches to its credit. It comprises two solid-propellant stages. The second stage, a Sonda II, is offered in two versions. One is designed to lift 50-80kg payloads to heights of 70-80km, and the other to carry 130-160kg to a height of around 50km.

Like most sounding rockets, Sonda III manages without attitude-control, relying instead on its launching rail and the stabilising influence of small fins. Three-axis stabilisation is provided for the payload, however, and recovery from the sea has been successfully demonstrated.

Sonda III's motor casings are made of steel, but the fins are of aluminium alloy. The propellant is a traditional mixture of 65 per cent ammonium perchlorate oxidiser, 15 per cent aluminium fuel, 15

per cent polybutadiene binder, and 5 per cent additives.

Sonda IV is the next sounding rocket in the series. Its main purpose is to prove rocket attitude-control, a requirement for VLS. Sonda III's first stage becomes Sonda IV's second stage. This "stepping stone" approach continues in a slightly different vein with Sonda IV, whose first stage is the basis of the first-stage cluster and second stage of VLS. Sonda IV is due to make its first flight in the second half of 1984.

CTA chose a secondary injection system (SIS) to control Sonda IV's attitude in pitch and yaw, after considering options that included a flexible-joint (i.e. gimballed) nozzle. SIS uses a fluid such as water to alter the thrust-line of the nozzle, without physically moving it (see sketch on page 385). It is a much simpler arrangement than the gimballed nozzles of liquid-propellant rockets, and thus represents a smaller technological risk.

Silicon chip

When SIS is incorporated in VLS, it will be a key element in attitude-control of the rocket. The SIS will be governed by a CTA-designed computer, using an imported silicon chip. CTA points out that VLS lacks navigation ability—it will achieve orbit purely on the basis of its attitude-control. Deputy CTA director Major-Brigadier Piva explains that low-Earth orbits are fairly insensitive to injection points, and that a satellite's boost motor can usually correct any deficiencies.

VLS is a four-stage solid-propellant rocket. Its first stage comprises a cluster of four motors—strap-ons in American parlance. The second stage is similar to one of the strap-ons, and sits in the core of the cluster. The strap-ons are roughly 5m long and 1m in diameter. Each contains about 6 tonnes of propellant and produces about 30 tonnes of thrust.

The third and fourth stages of VLS are smaller, purpose-built elements. Stage three is roughly 3.5m long and 1m in diameter, and holds a few tonnes of propellant. Stage four measures 1m by 1m and holds about 850kg of propellant. CTA has yet to decide whether to use glassfibre-reinforced plastic (GRP) casings for these two stages (steel is used in the first two stages). VLS will weigh about 40 tonnes at lift-off.

CTA quotes VLS payload as 150kg into a 250km by 550km orbit inclined at 98°, or 100kg into a 700km-high circular orbit inclined at up to 30°. These are preliminary figures, however, and *Flight* understands that the payload could grow to 200kg. All of the VLS launches will be made from the new Brazilian launch-site, Alcantara. First VLS flight is now planned for the second half of 1989.

Brazil's current launch pad is at Barreira do Inferno, near Natal, almost 6° South of the Equator. Its proximity to the Equator makes the site ideal for sounding rocket exploration of the upper atmosphere. Some 350 launches have been made from Barreira do Inferno during the range's 17-year life, many of them sounding rockets from countries such as the USA and Europe.

The range now handles anything from 12 to 100 sounding rockets each year. It is also responsible for tracking the third stage of Arianes launched from nearby Kourou, on behalf of the European Space Agency. A Sonda IV launch pad is now being built at Barreira do Inferno in preparation for the first flight next year. The range is operated by the Brazilian Air Force.

Two shortcomings have prevented further development of Barreira do Inferno. Nearby inhabited land restricts launches in a northerly, or polar direction, and there is lack of room for expansion. So Brazil is pressing ahead with development of a new range at Alcantara.

Like its predecessor, Alcantara will benefit from the "clear skies" weather of Brazil's northeast coast. Being even closer to the equator—Alcantara's latitude is just over 2° South—the range is ideal for launches to equatorial orbit. The absence of nearby habitation also makes Alcantara suitable for firings to polar orbit. Finally, Alcantara will comprise some 520km² of land, leaving plenty of room for growth.

Negotiations for the purchase of land for Alcantara have begun, and it is hoped to begin the construction of facilities in 1985. Some 500 families will be displaced by the new range, and they will be re-located in a purpose-built village nearby.

Own runway

Unlike the previous range, Alcantara will have an industrial area that is widely separated from the launch pads. It will also have its own runway, initially about 1,500m long. VLS is the main impetus for Alcantara, and a single launch-pad is to be built for it. The first flight from Alcantara will be made by a sounding rocket, probably during 1987. VLS makes its debut about two years later.

Brazil is excited about the prospects for Alcantara, which it claims will be "the best launch site in the world". It plans to offer other countries the opportunity of building launch pads for their own rockets on land leased from Alcantara. Such a proposition could prove attractive, particularly to land-locked countries without a suitable site, and perhaps even to rocket-orientated nations such as the USA.

Another idea is to extend Alcantara's runway to allow a landing by Nasa's Space Shuttle Orbiter. The basic idea would be to operate Shuttle, or its successor, in much the same way that airlines fly airliners, rather than Brazil attempting to create a re-usable launcher of its own. This is a far-reaching concept, however, and the economics of building a Shuttle-launch pad in Brazil would need to be thoroughly investigated before making a decision. Full marks to Brazil for the idea.

Brazil currently channels just over \$10 million a year into the space activities of CTA and INPE—comparatively little by western standards. This figure is expected to rise, in real terms, over the next few years, but then to drop as the new launch pad becomes established.

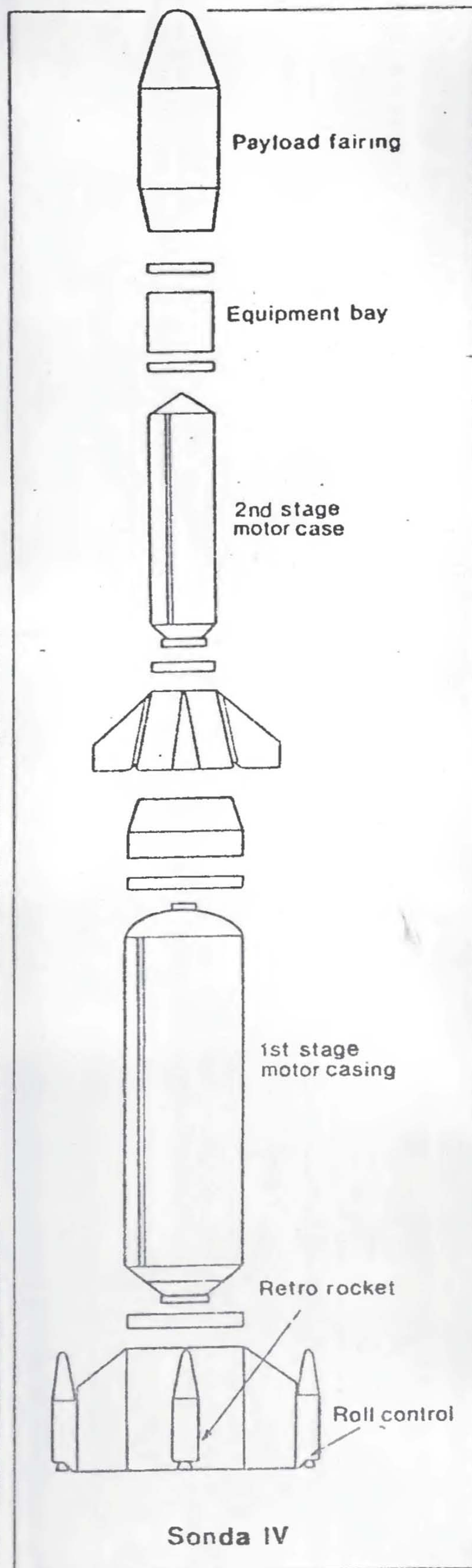
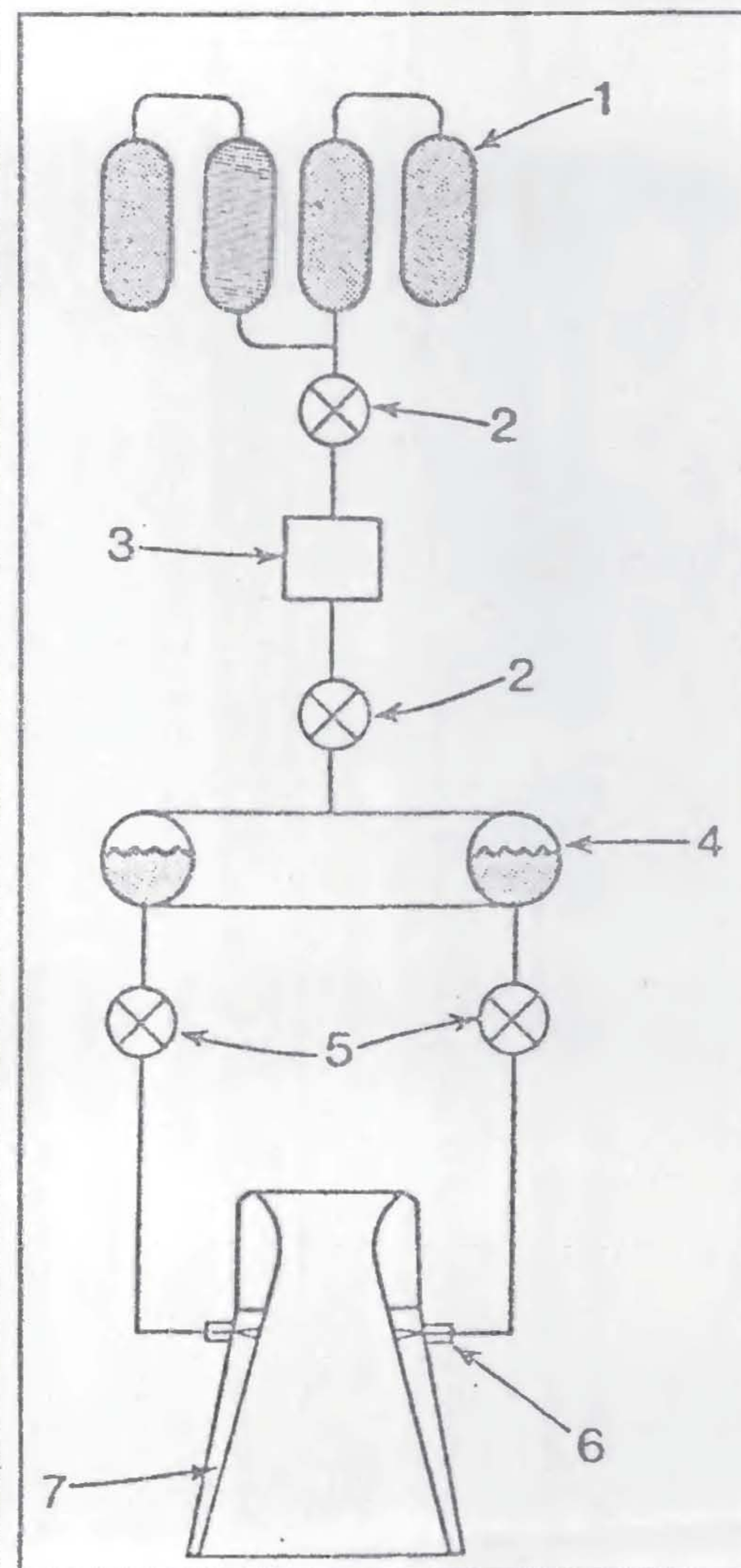
Total cost of developing VLS and the satellites it will launch is put at \$500 million in 1983 prices. About \$300 million of this is for VLS development, including

four flight-standard rockets, plus \$40 million-\$60 million for the Alcantara range. Satellite work absorbs the remaining \$200 million, which includes three flight-ready craft and a ground station.

In acting as prime contractor for the rocket work, CTA has enlisted the help of Brazilian industry. The principal subcontractors are: Electrometal and Picchi for metal parts, including motor casings; Avibras for propulsion; Imbel for propellants; ABC Systems for electronics; Esca for systems; and DF Vasconcellos for guidance, control, and optics. CTA is keen to involve Embraer, perhaps in a leading role, but Brazil's leading aerospace company feels that it has enough on its plate with its civil and military aircraft work.

CTA director Major-Brigadier Menezes emphasises that Brazil's space programme is a civil one. The organisation is itself largely civilian—only two-thirds of its 6,400 staff are military personnel. As Brazil is the largest country in South America, it is natural that it should emerge as a leader in aerospace. Menezes points out that Argentina also has a space programme, however, and that it is probably as advanced as Brazil's. Indeed, Argentina was invited to join in Brazil's efforts, but has so far declined.

One thing is certain. Rockets and satellites will be the dominant technologies of the future, and any nation involved with them must be on to a winner.



Above Sonda IV is designed to prove rocket attitude-control, for later use in VLS. Its main elements are held together by V-clamps

Left CTA is developing a secondary injection system (SIS) to alter thrust-line without nozzle movement. SIS will be used in Sonda IV, and later VLS. 1 High-pressure nitrogen 2 Valves 3 Pressure regulator 4 Toroidal tank 5 Shut-off valves 6 Injection valves 7 Nozzle